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ILS/MLS Comparison Tests at Miami/Tamiami, Florida Airport

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July 1989

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16. Abstract

A series of flight tests were performed by the Federal Aviation Administration (FAA) Technical Center at the Miami/Tamiami, Florida Airport, to compare the course quality of an instrumented landing system (ILS) with a collocated Microwave Landing System (MLS). The Technical Center's test bed MLS was transported to and collocated with the commissioned category I ILS on runway 9R at Tamiami. The flight data that was collected indicate that the MLS has less scalloping than the ILS and the MLS azimuth is unaffected by overflight interference.

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Dade County Airport Department

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EXECUTIVE SUMMARY

A series of tests were performed at the Miami/Tamiami, Florida Airport, to compare the course quality of an instrumented landing system (ILS) with a collocated microwave landing system (MLS). The Technical Center's test bed MLS was transported to and collocated with the commissioned category I ILS on runway 9R at Tamiami. The flight data that were collected indicate that the MLS has less scalloping than the ILS and the MLS azimuth is unaffected by overflight interference.

BACKGROUND

During the period March 24-27, 1989, series of tests were performed at the Miami/Tamiami, Florida Airport to compare the course quality of an instrument landing system (ILS) with a collocated microwave landing system (MLS). These ILS/MLS comparison tests were part of a series of tests performed at Tamiami during March which included verifying ILS/MLS collocation standards as well as a demonstration of MLS Area Navigation (RNAV) capability.

Tamiami Airport is located approximately 5 miles southwest of Miami and is operated by the Dade County Airport Department. The airport has very flat terrain and is a general aviation airport with very high traffic volume. The ILS, which consists of an 8-element log periodic localizer array and a null reference glide slope array, services runway 9R which is 5,000 feet in length and 150 feet wide. It is a category I commissioned facility. The Federal Aviation Administration (FAA) Technical Center Test Bed MLS, which consists of a Bendix 2^{o} beamwidth azimuth station and a 1.5^{o} beamwidth elevation station, was collocated with the ILS in accordance with the proposed amendments to attachment G to part I of the International Civil Aviation Organization (ICAO) Annex 10 for these tests. Figure 1 is a drawing of the MLS azimuth and elevation stations used in these tests.

TEST PROCEDURES

The localizer is sited, on the runway centerline extended, 1784 feet beyond the stop end of the runway. The MLS azimuth was installed with the rear of the shelter 200 feet in front of the localizer and was symmetrical about the centerline extended. Figure 2 is a drawing of the localizer and azimuth locations. The glide slope is sited 1025 feet back from threshold and 324 feet to the right (as seen by the pilot on an approach) of runway centerline. The elevation station was installed to place the front of the antenna 906 feet from threshold and 274 feet to the right of centerline. This location was to the runway side of a line from the glide slope antenna to the runway centerline at threshold and provided for coincident threshold crossing heights between the glide slope and elevation systems. Figure 3 shows the locations of the glide slope and elevation antennas.

All of the data collected were airborne data using a fully instrumented Convair 580 (CV-580). A Bendix ML-201A MLS receiver was used to collect the MLS data; a Bendix RNA-34AF navigation receiver was used to collect the localizer and glide slope data. Both of these receivers output both analog and digital data. The aircraft tracking was performed using a Warren Knight balloon theodolite and a JC Air FM radio telemetric theodolite (RTT). DME ranging data, for reference information only, was collected using an E-Systems DME/P located near the azimuth and localizer. Both analog (strip chart recorder) and digital (Kennedy 9-track recorder) data were collected. The analog was used for real time "quick look" information while the digital data was processed post flight and is used in this report.

The MLS azimuth was installed to have the runway heading coincident with the localizer; the MLS elevation was installed to have a coincident runway crossing height with the glide slope. When collecting azimuth/localizer data, the pilot flew the MLS azimuth signal and azimuth, localizer and RTT data were collected.

When collecting elevation/glide slope data, the pilot flew the MLS elevation signal and elevation, glide slope and RTT data were collected.

RESULTS AND ANALYSIS

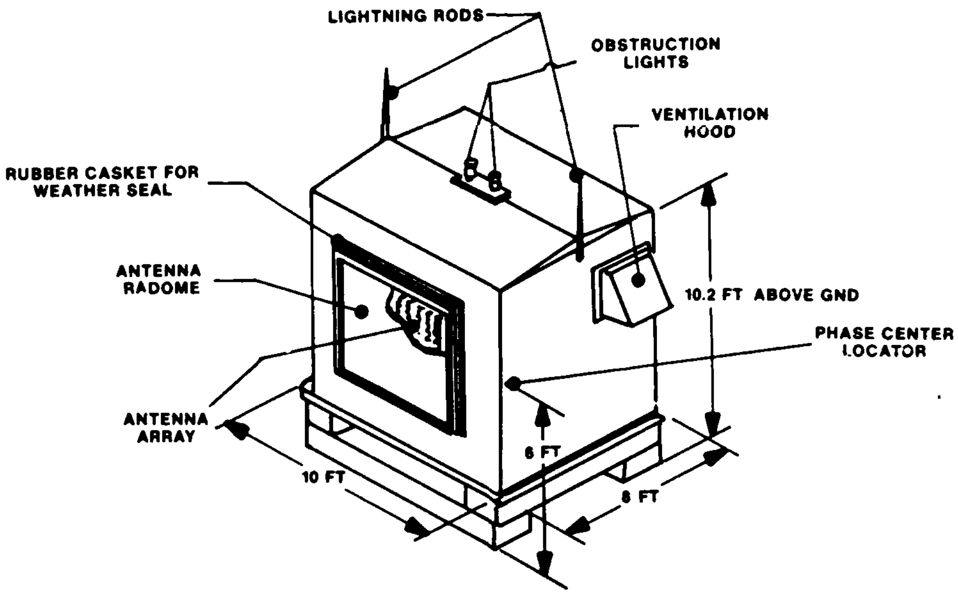
The data from other tests performed during this series indicated that collocating an MLS azimuth with a localizer and an MLS elevation with a glide slope does not affect the quality of the course structure of the ILS. Therefore, any differences between the ILS and MLS noted in this report were not caused by collocating the systems. ILS and MLS course error data are normally presented differently due to different specifications for each system. The ILS data, both localizer and glide slope, are raw error (receiver cross pointer minus RTT) and is not filtered. The MLS data presented in this report is also unfiltered raw error so that all comparisons are between raw error data.

Figure 4 is a plot of the localizer error for a centerline approach. The error stays within the prescribed error limits, but the rapid high frequency oscillations at 0.5, 1.5, 4.5, and 7.0 miles are caused by other aircraft flying between the localizer and the test aircraft (overflight interference). In addition, there is a lower frequency scalloping effect on the signal from 2 miles to threshold. Figure 5 is a plot of the raw MLS azimuth data for the same approach. It is obvious from the data that the MLS is unaffected by the overflight interference and does not have any scalloping. The tolerance limits on the MLS data are those for the PFE filtered data and are for reference only. Figures 6 (localizer) and 7 (azimuth) are the raw error traces from a second approach with the same trends evident. There is overflight interference on the localizer at 4 and 6 miles and scalloping in the final 2 miles, while the azimuth signal is unaffected by the overflight interference and shows no scalloping.

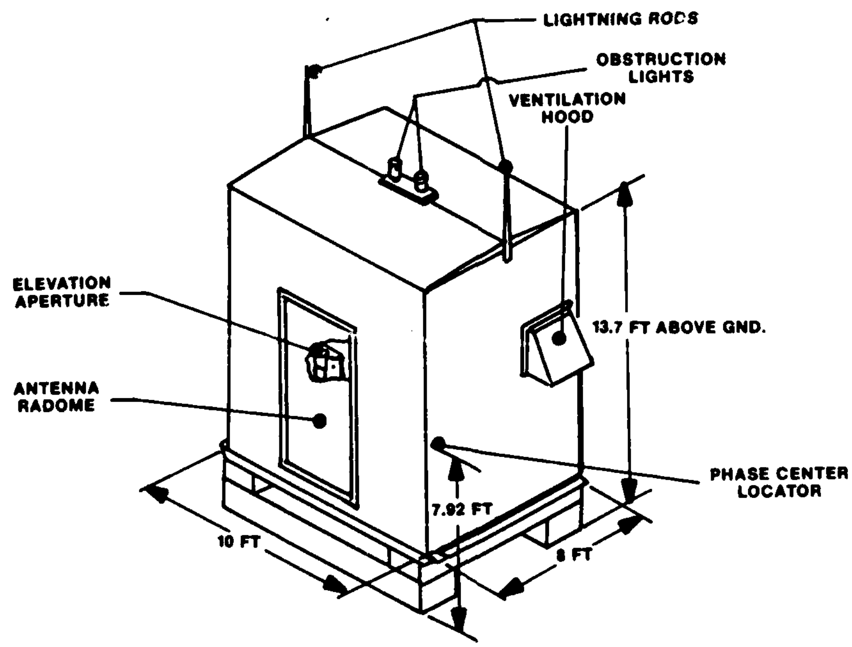
Figure 8 is the glide slope raw error trace from an approach while figure 9 is the MLS elevation raw error from the same approach. The elevation signal has less scalloping and fewer course bends than the glide slope. Figures 10 (glide slope) and 11 (elevation) are raw error traces from a second approach and show the same trends as the first approach.

RESULTS AND CONCLUSIONS

The data collected show that the Microwave Landing System (MLS) signal has less scalloping and fewer bends than a category I instrument landing system (ILS) during an approach. In addition, the MLS azimuth signal is unaffected by overflight interference which causes severe perturbations in the localizer signal.



SHELTERED CONFIGURATION
AZIMUTH SUBSYSTEM



SHELTERED CONFIGURATION
1.5° ELEVATION SUBSYSTEM

FIGURE 1. DRAWING OF MLS AZIMUTH AND ELEVATION STATIONS

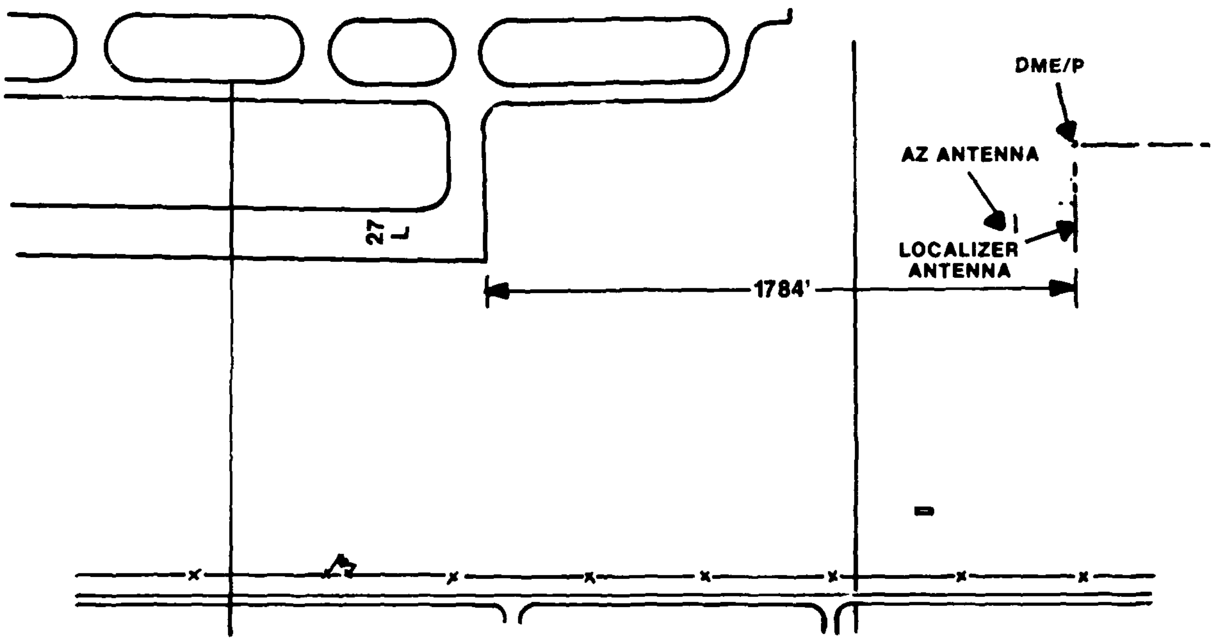


FIGURE 2. LOCALIZER AND AZIMUTH LOCATIONS

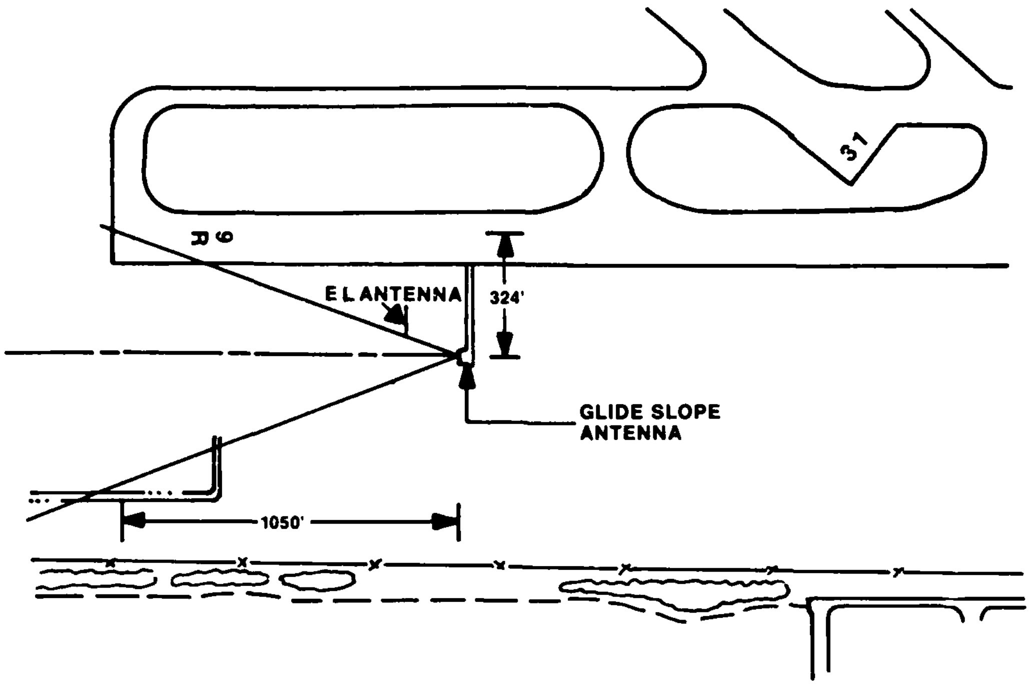


FIGURE 3. GLIDE SLOPE AND ELEVATION LOCATIONS

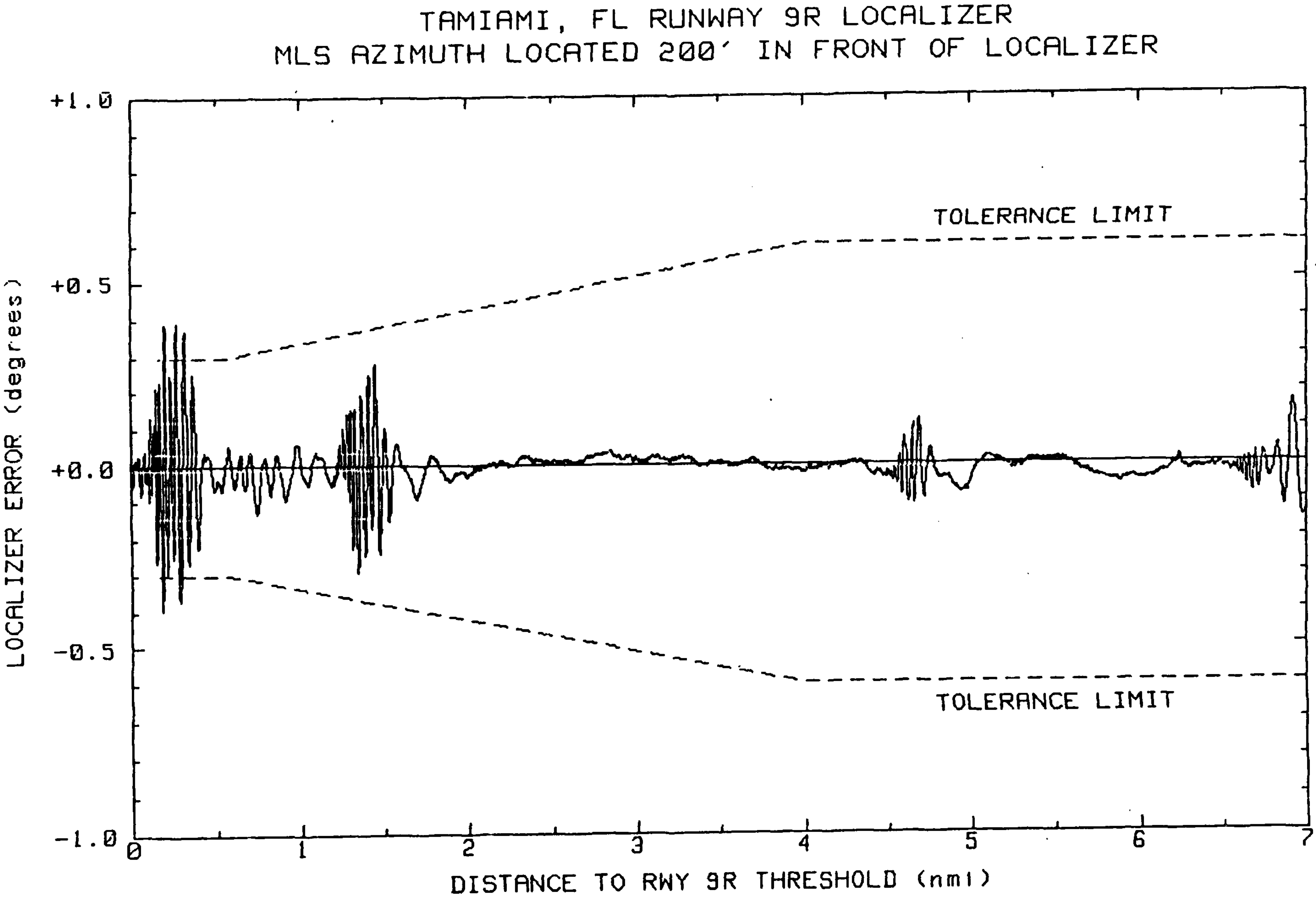


FIGURE 4. LOCALIZER ERROR PLOT FOR A CENTERLINE APPROACH

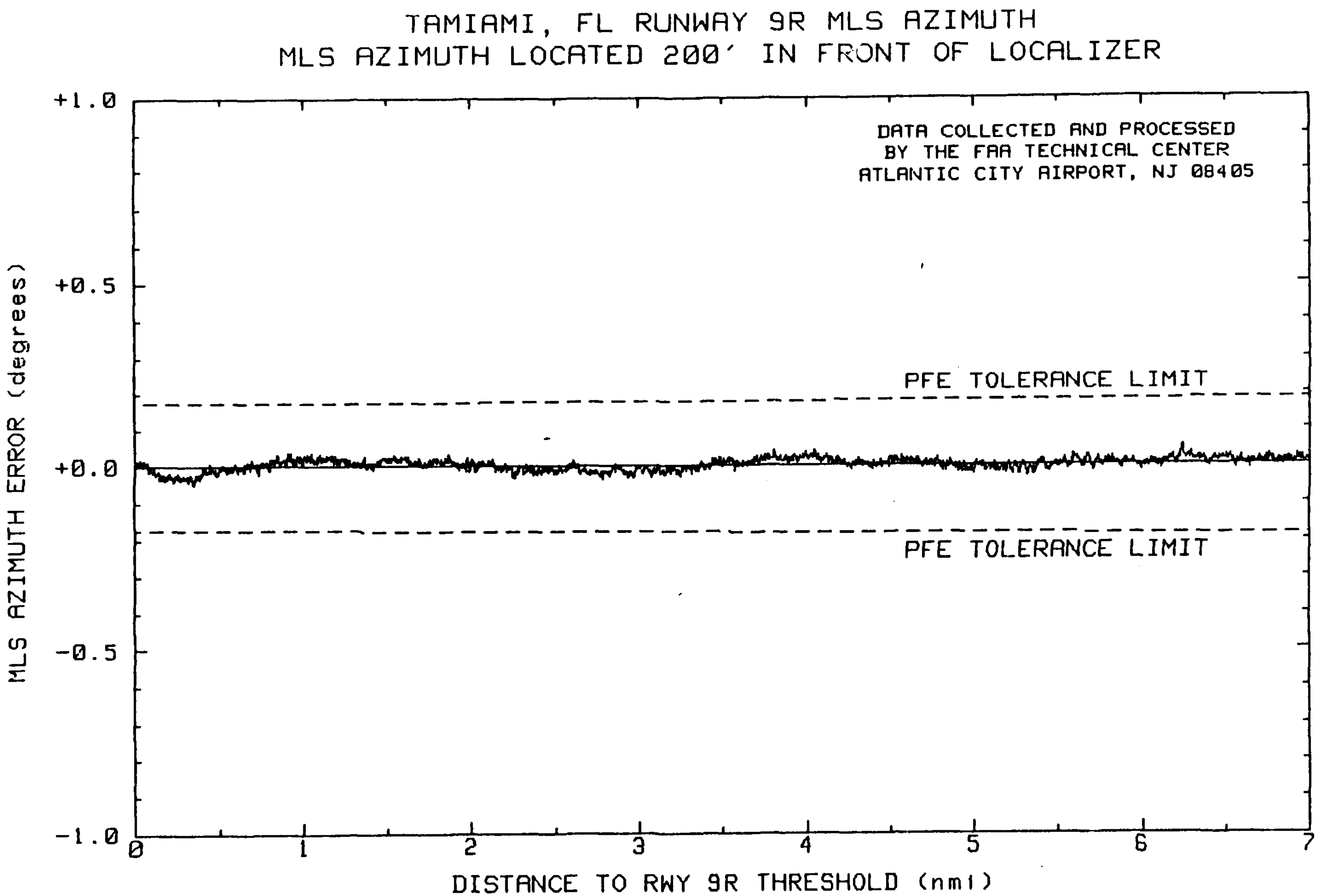


FIGURE 5. AZIMUTH RAW ERROR PLOT FOR A CENTERLINE APPROACH

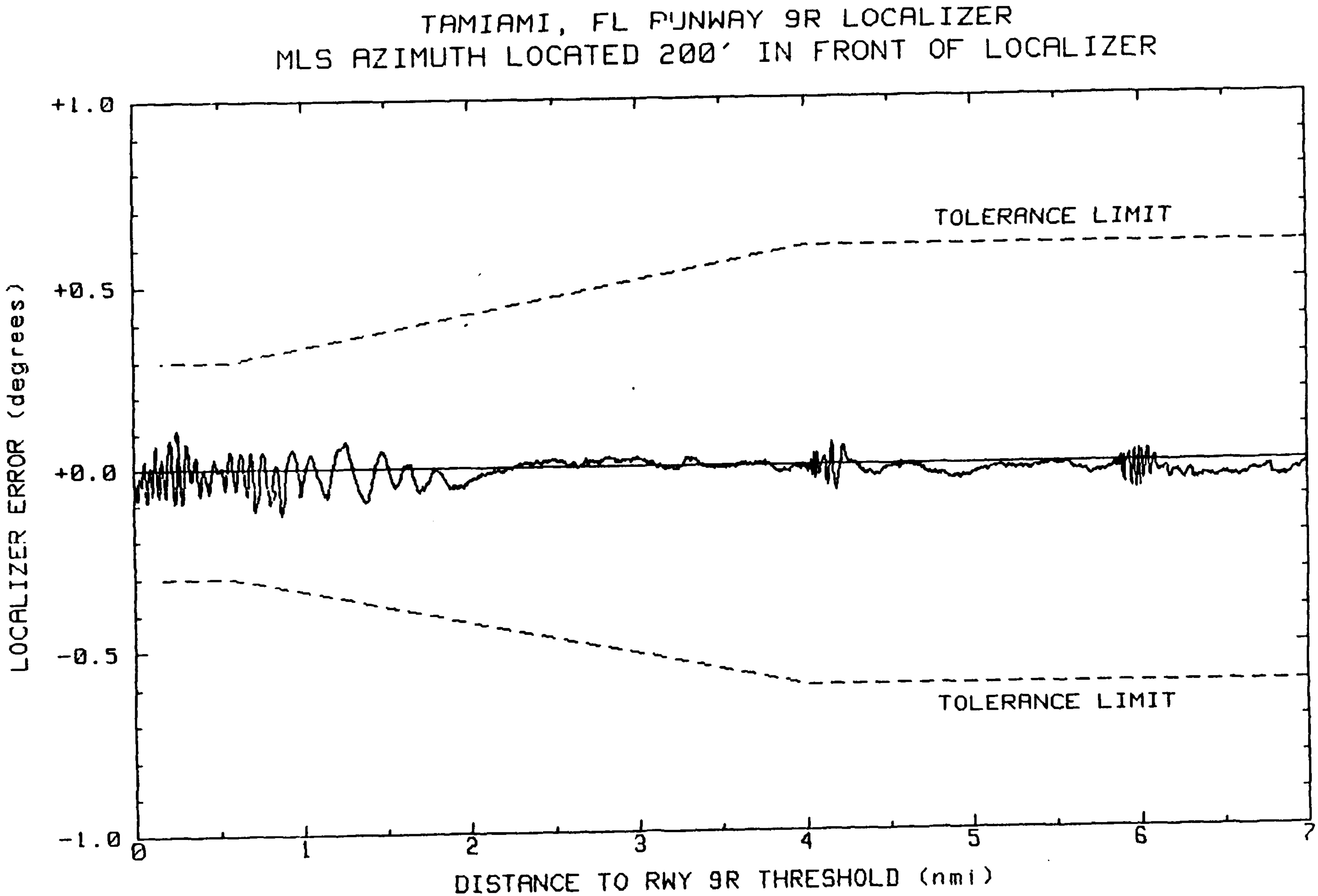


FIGURE 6. LOCALIZER ERROR PLOT FOR A SECOND CENTERLINE APPROACH

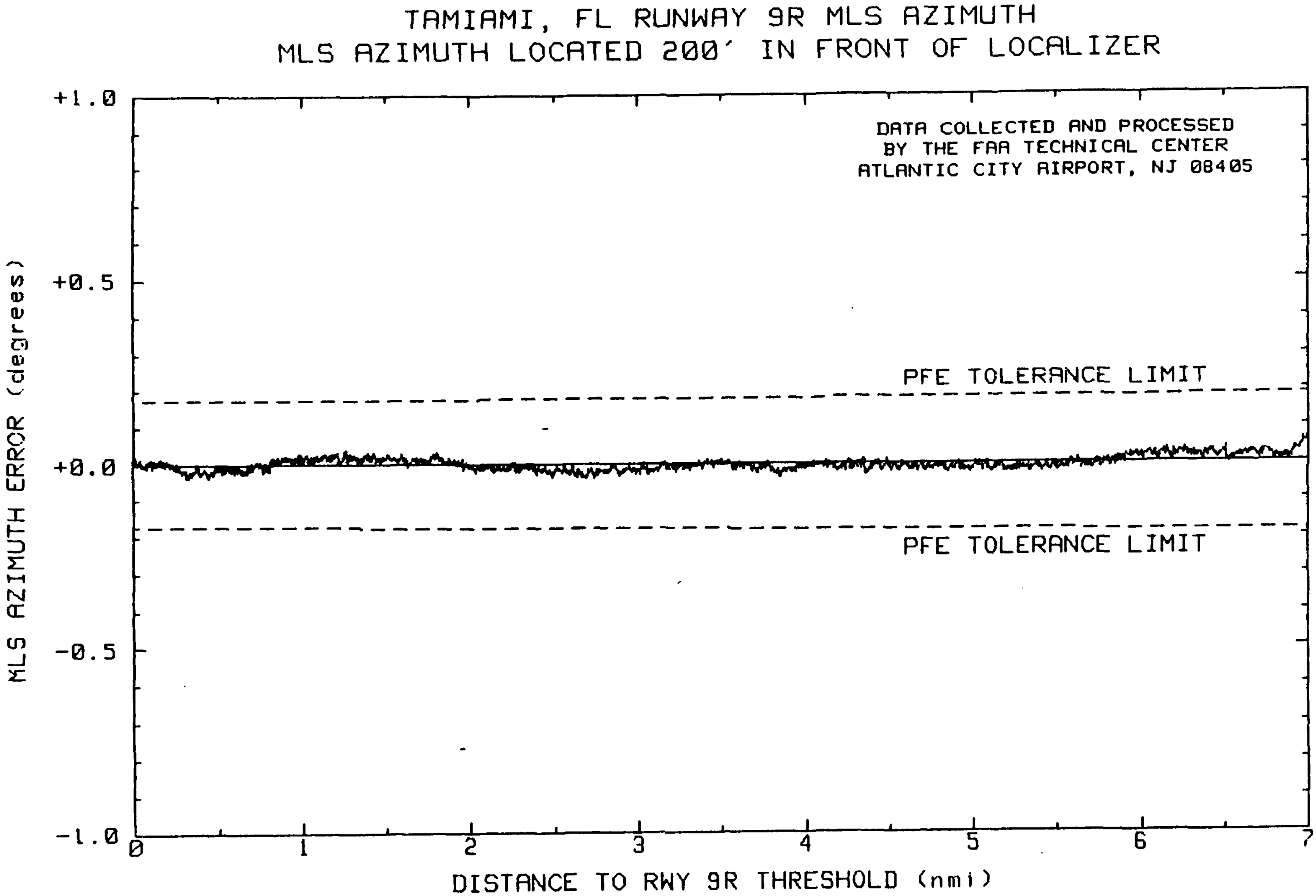


FIGURE 7. AZIMUTH RAW ERROR PLOT FOR A SECOND CENTERLINE APPROACH

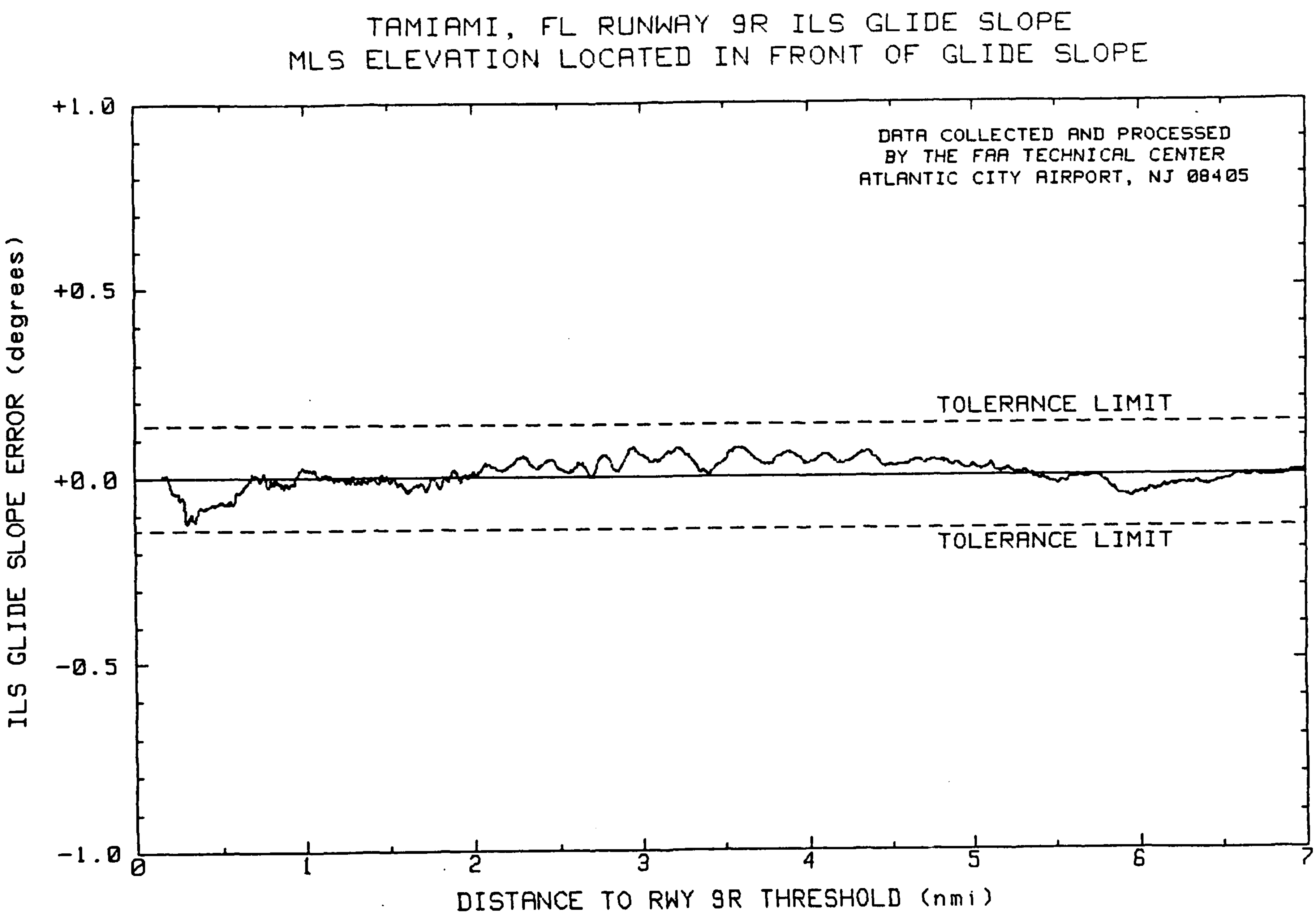


FIGURE 8. GLIDE SLOPE ERROR PLOT FOR A CENTERLINE, 3° APPROACH

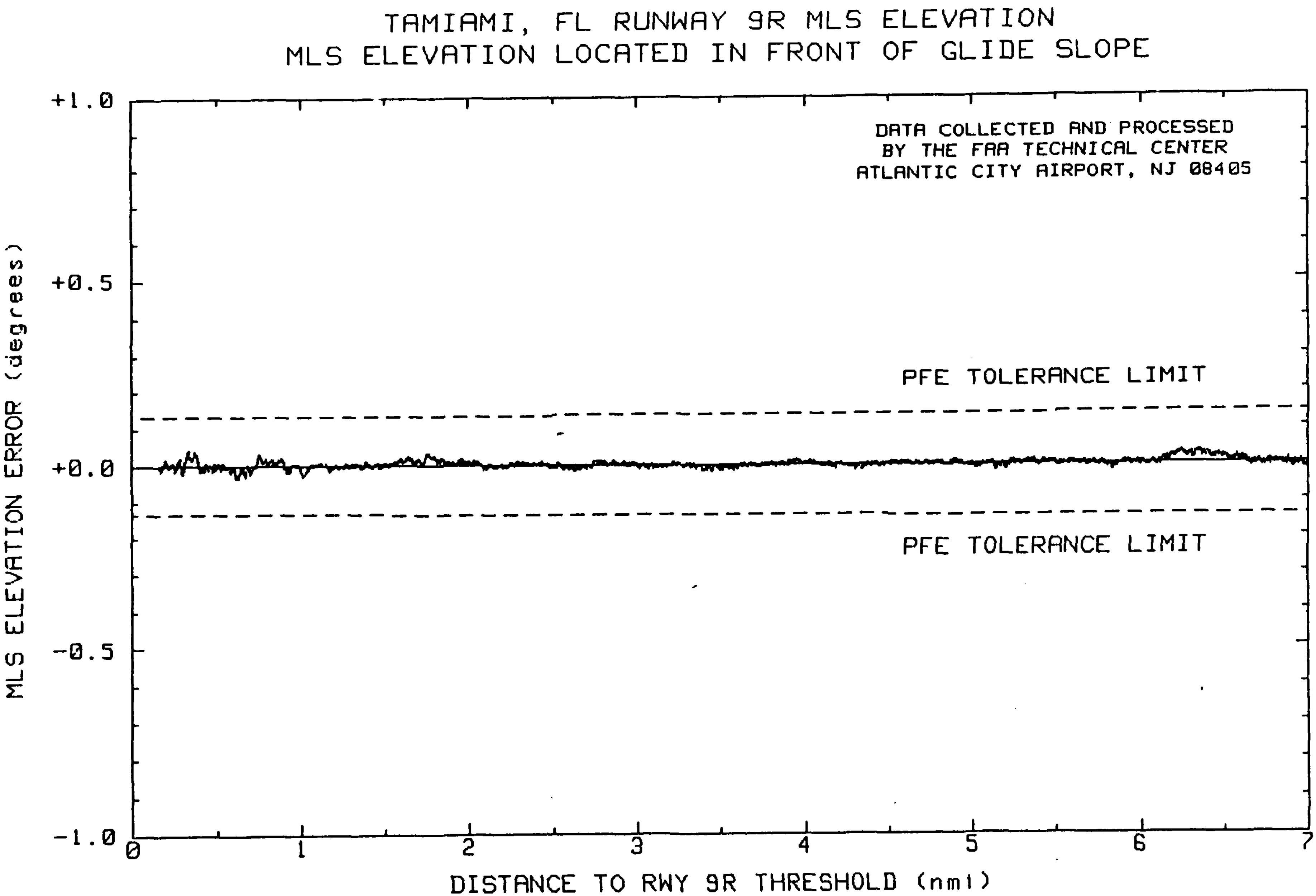


FIGURE 9. ELEVATION RAW ERROR PLOT FOR A CENTERLINE, 3° APPROACH

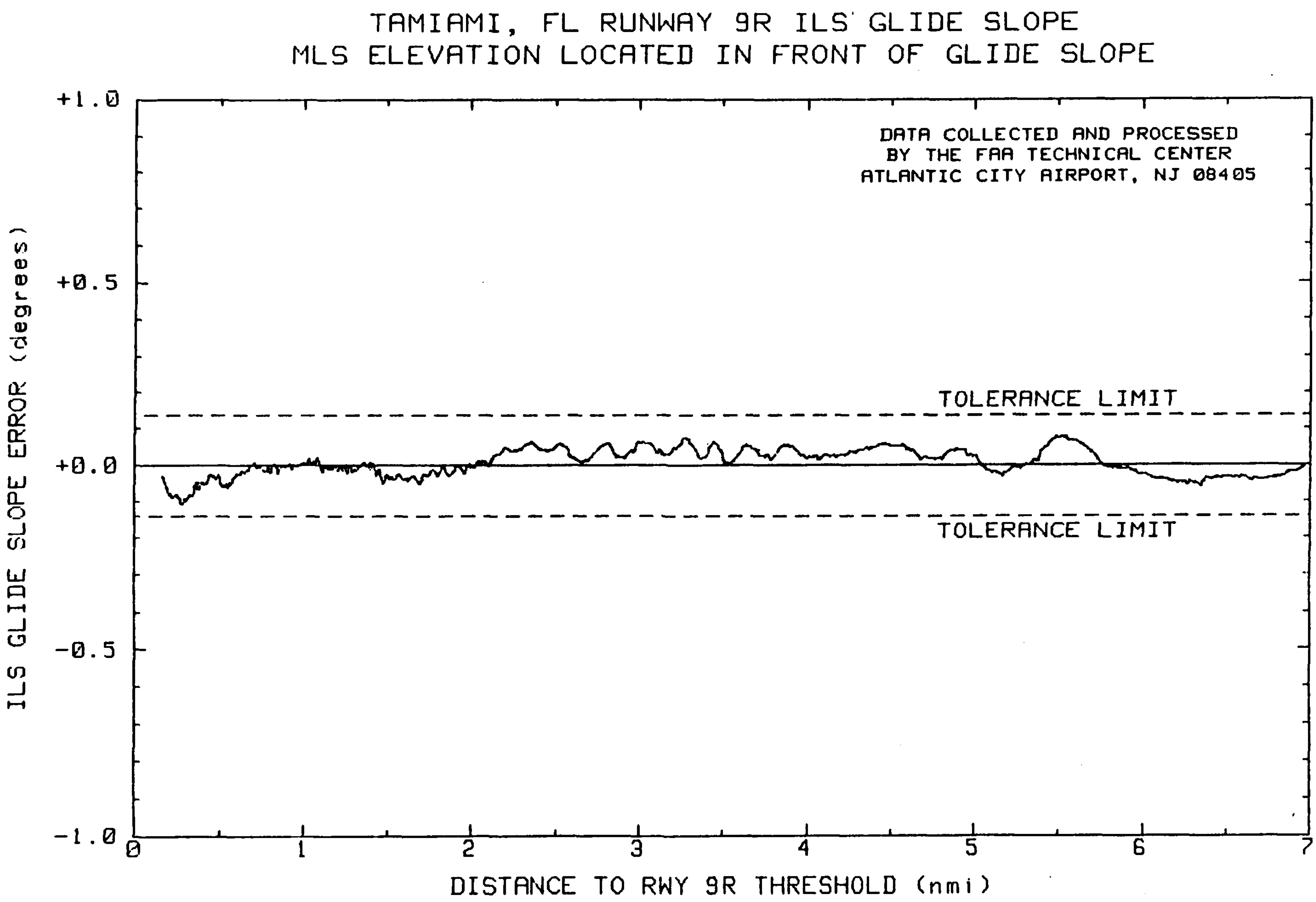


FIGURE 10. GLIDE SLOPE ERROR PLOT FOR A SECOND CENTERLINE, 3° APPROACH

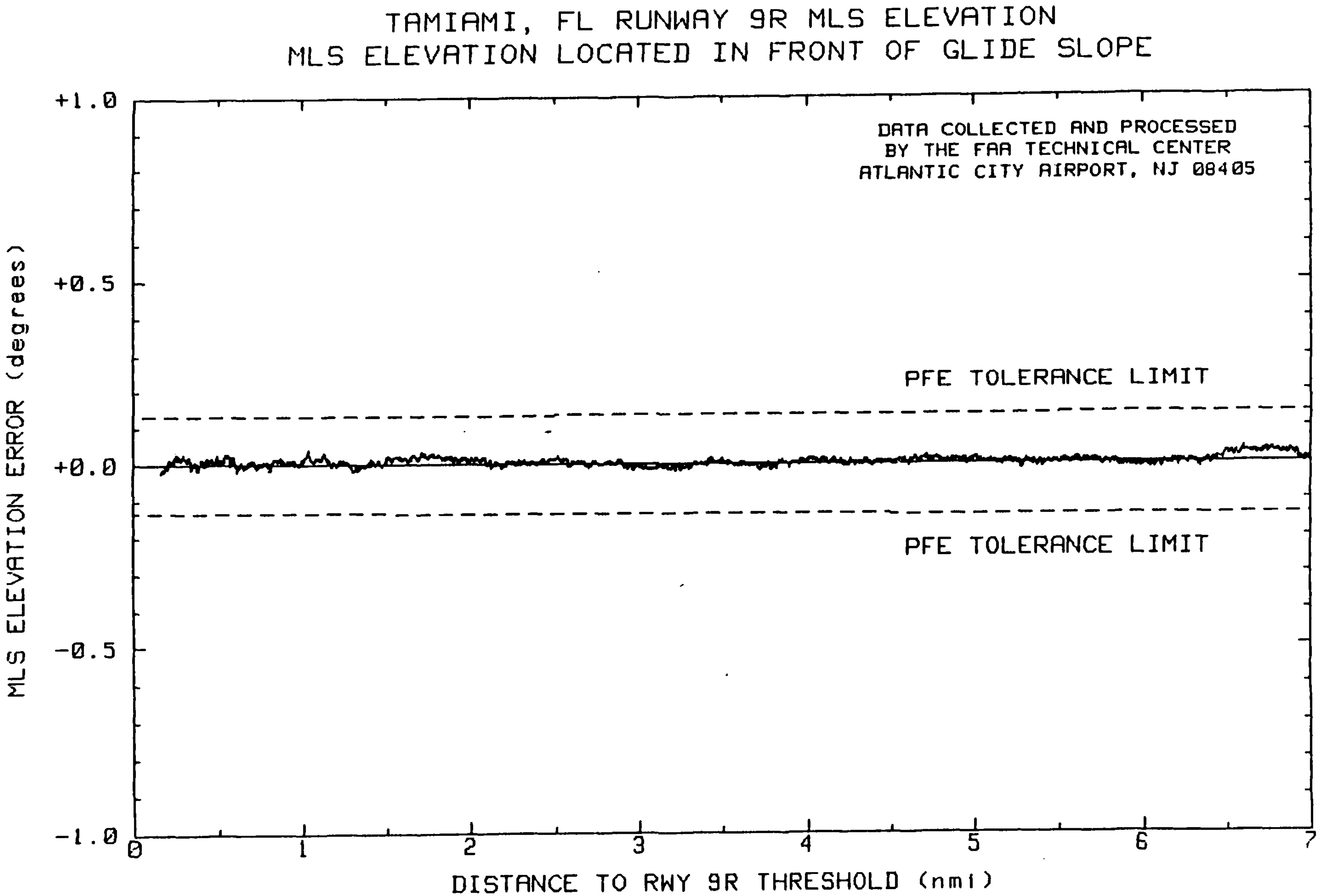


FIGURE 11. ELEVATION RAW ERROR PLOT FOR A SECOND CENTERLINE, 3° APPROACH